CHEMICAL HAZARD SUMMARY

Canadian Centre for Occupational Health and Safety
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PHTHALATES

(Phthalate Esters)

SCOPE OF THE DOCUMENT

This document focuses on the hazards of phthalates. The toxicity, fire and explosion hazards, and reactivity of phthalates are described. Details of protective measures, storage, handling, clean-up, disposal and first aid are also given. Information relevant to the workplace is emphasized. Special attention is given to the main hazard presented by phthalates.

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I. MAIN CONCERNS

Very large doses of some phthalates, when fed to animals, cause cancer and birth defects. There are no reports of such effects in humans. The main concerns for occupational exposure to phthalates are eye and skin irritation.

II. OCCUPATIONAL EXPOSURE

Phthalates are compounds widely used as plasticizers in the manufacture of plastics. They are added to certain types of plastics, particularly polyvinyl chloride (PVC), to make the plastic softer and more flexible. Plastics made without the use of plasticizers would be brittle and rigid.

Phthalates are found in virtually every major type of plastic consumer product including construction materials, automotive goods, household products, clothing, toys, packaging and medical products. Smaller amounts are used in products such as insect repellents, cosmetics, ammunition, lubricants and electrical insulating fluids.

The most important phthalate, in terms of production and occupational exposure, is di(2-ethylhexyl) phthalate (DEHP), also called di-octyl phthalate (DOP) and di-sec-octyl phthalate. Other important phthalates are dibutyl phthalate (DBP), butyl benzyl phthalate (BBP), dinonyl phthalate (DNP) and di-isodecyl phthalate (DIDP).

Occupational exposure to phthalates occurs when they are being produced and when they are being added to plastic resin. Exposure may also occur in the processing of flexible PVC. All stages in the processing of flexible PVC require heating, usually at temperatures of 160 to 180°C.

Phthalates are colourless, oily liquids which have high boiling points (usually above 200°C) and very low vapour pressures (very low tendency to evaporate). Consequently, at normal room temperature, very little vapour will be found in the air. At higher temperatures (above 30°C), phthalates may be present in the air in the form of liquid, mist or aerosol. Most exposures are a result of inhalation of the mist. When high concentrations of phthalates are present in the air, this mist is clearly visible as a cloud or fog.

Air concentrations of phthalates (total DEHP, BBP and DIDP) were recorded in one PVC-processing plant at between 0.02 and 0.4 milligrams per cubic metre (mg/m^3).[1]

DEHP was detected at levels of 0.4 to 3.2 mg/m^3 in the air of a factory in which nylon and vinyl coatings containing phthalates were applied to a variety of products.[2] Surveys from several countries have reported exposures of 0.01 to 66 mg/m^3.[1]

In the only available study on exposure to DEHP in a plant manufacturing phthalates, airborne concentrations of DEHP ranged from 0.02 to 4.1 mg/m^3.[3]

Phthalates are poorly absorbed through the intact skin. Ingested (swallowed) and inhaled phthalates are readily absorbed into the body.

General information on the route of exposure is available in the CCOHS publication "How Workplace Chemicals Enter the Body."[4]

III. HEALTH HAZARDS

Removal from the Body

Phthalates taken into the body are rapidly broken down in the liver.

The breakdown products formed by the liver cause many of the toxic effects of phthalates. Most phthalates and their breakdown products are excreted in the urine.

Effects of Short-Term Exposure in Humans

Inhalation

At room temperature, vapour exposures are highly unlikely. High temperature processes may generate enough mist to cause toxic effects. Symptoms can include coughing, sneezing, nose bleeds, dizziness, headache, nausea, and irritation of the nose and throat. Irritant effects become noticeable at about 5 mg/m^3. Concentrations of 40 mg/m^3 become almost unbearable owing to intense irritation.

Eyes

Phthalate mist may cause irritation, redness and burning of the eyes. The irritant effects are observed at about 5 mg/m^3. Accidental splashing of liquid phthalates into the eyes may produce considerable pain but causes no permanent damage.[5]

Skin

Phthalate mist can irritate the skin. Redness, burning and inflammation (contact dermatitis) may occur.

Liquid phthalates are only slightly irritating to the skin. If the chemical is held in contact with the skin, such as under clothes or shoes, skin burns may develop.

Ingestion

Ingestion of large quantities of phthalates (about 10 g) has resulted in nausea, vomiting, dizziness and diarrhea.

Effects of Long-Term Exposure in Humans

Carcinogenic Effects

Information available is very limited. The International Agency for Research on Cancer (IARC) found that there are no adequate studies on cancer incidence related to exposure to DEHP or other phthalates in humans, but concluded that there is sufficient evidence that it causes cancer in animals.[6] The National Institute for Occupational Safety and Health (NIOSH) has classified DEHP a potential occupational carcinogen.[7]

Mutagenic Effects

Information available is very limited. A group of 10 workers exposed to DEHP in concentrations of 0.01 to 0.16 mg/m^3 for 10 to 30 years showed no increase in the number of chromosomal abnormalities when compared to unexposed controls.[8]

Reproductive Effects

No reports have been found on the effects of phthalates on pregnant women.

Nervous System

Two studies suggested that long-term exposure to phthalates in the workplace may have an effect on the peripheral nervous system,[9,10] but both studies have been severely criticized. Information on exposure levels was vague. There was no adequate control group, and non-occupational factors such as age and alcohol consumption were not discussed. There was also exposure to a well-known neurotoxic agent, tri-orthocresyl phosphate. Other studies found no effects on the peripheral nervous system in workers exposed to phthalates.[11,12]

Inhalation

Repeated or prolonged exposure to phthalate mist may result in bronchitis, lung disease (emphysema), and asthma.

Skin

Prolonged or repeated contact with liquid phthalates may cause skin burns. Some phthalates can be absorbed through the skin.

Eyes

Prolonged or repeated exposure can cause eye irritation.

Toxicity Data in Animals and Laboratory Tests

The poisoning strength of a compound can be estimated from the LD_{50} obtained in animal tests. LD stands for lethal. The LD_{50} is the amount of a chemical (weight of chemical per weight of animal) which is needed to kill one-half (50 percent) of the test animals. Test animals are usually rats, mice or other rodents. Routes of exposure are usually by mouth (oral) or through the skin (dermal).

Oral LD_{50} values for phthalates range from 8-34 g/kg and they are considered practically non-toxic when given by mouth.[13]

Further general information on the LD_{50} is available in the CCOHS publication "What is an LD_{50}?"[14]

Carcinogenic Effects

IARC has concluded that there is sufficient evidence that phthalates cause cancer in animals.[6] Phthalates have been found to cause tumours in experimental animals in tests by the US National Toxicology Program. An increase in the incidence of liver tumours was observed in rats and mice fed diets containing large amounts (3000 to 12,000 mg/kg) of DEHP for 2 years. An increased incidence of leukemia was observed in female rats fed diets containing 12,000 mg/kg butyl benzyl phthalate (BBP).[15] A closely related plasticizer, di(2-ethylhexyl) adipate (DEHA), has also been shown to be carcinogenic at high doses in animals.[16]

Reproductive Effects

In animal tests, extremely large doses of DEHP given by mouth can be toxic to the embryo and the fetus and can cause birth defects. Although not stated in the reports, it is likely that there was some maternal toxicity at the doses used, and this may have been the reason for the effects seen on the embryo and fetus.[6,17]

Mutagenic Effects

DEHP is not mutagenic when tested in bacterial systems such as the Ames Test.[6] Other tests give inconsistent results. The majority of tests have been negative, but some studies suggest that it may be a very weak mutagen.[6]

IV. FIRE AND EXPLOSION HAZARDS

Phthalates have high flashpoints (for example, DEHP has a flashpoint of 199°C or 425°F) and do not burn easily. Thus, phthalates have a low fire risk.

V. CHEMICAL REACTIVITY

Phthalates are stable under normal conditions of processing and use, but can be reactive with strong acids, bases and oxidizing agents.

VI. EXPOSURE LIMITS

Many Canadian jurisdictions have exposure limits similar to those established by the American Conference of Governmental Industrial Hygienists (ACGIH). The following exposure limits have been established by ACGIH for DEHP:

A time-weighted average limit (TWA) of 5 milligrams per cubic metre (mg/m^3).

A short-term exposure limit (STEL) of 10 milligrams per cubic metre (mg/m^3).

Similar exposure limits exist for DBP, DEP and DMP. No STEL has been established for DEP or DMP.

Contact the appropriate authority in your jurisdiction for details of the specific regulations which apply. Refer to ACGIH documentation for information on the exposure limits.

VII. EXPOSURE CONTROLS

In many operations where phthalates are used in small amounts at room temperature, general or dilution ventilation may be adequate to keep exposures under control. Where phthalates are heated or a mist is created, local exhaust ventilation systems should be used.

Protective Clothing

Wear protective clothing (gloves, aprons, coveralls, boots) as needed to prevent exposure of skin to liquids or mists. Phthalates are strong solvents and many materials do not provide adequate protection. Clothing coated with neoprene, nitrile rubber or Viton provides good protection. Natural rubber appears to be unsuitable for protection against penetration by phthalates.[18]

Any clothing which becomes contaminated with phthalates should be removed promptly, discarded or laundered separately, and thoroughly dried before reuse.

Wear splash-proof chemical safety goggles or a face shield (8 inch minimum) whenever there is a risk of splashing liquid into the eyes. Eyewash fountains and safety showers should be located in areas where splashes of phthalates are likely to occur.

Respiratory Protection

Factors to be considered when implementing a respiratory protection program include:

- Selection of appropriate respirators
- Respirator fit testing
- Respirator maintenance
- Worker training
- Inspection
- Cleaning
- Program evaluation

These factors are described in more detail in CSA Standard Z94.4-M1982, "Selection, Care, and Use of Respirators," available from the Canadian Standards Association, Rexdale, Ontario, M9W 1R3.

Since NIOSH has classified DEHP as a potential occupational carcinogen,[7] the following respiratory protection guidelines have been recommended:*

* The following recommendations apply only to equipment approved by NIOSH and MSHA (Mine Safety and Health Administration).

At any detectable concentration: Any supplied-air respirator with a full facepiece and operated in pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus (SCBA) operated in pressure-demand or other positive mode; any SCBA with a full facepiece and operated in a pressure-demand or other positive-pressure mode.

Escape: Any air-purifying full facepiece respirator with a high-efficiency particulate filter; any appropriate escape-type SCBA.

For dibutylphthalate (DBP) and dimethylphthalate (DMP), NIOSH recommends the following respiratory protection guidelines:

Particulate concentrations of 50 mg/m^3 or less: Any dust and mist respirator with a full facepiece.

Particulate concentrations of 125 mg/m^3 or less:* Any powered air-purifying respirator with a dust and mist filter; any supplied-air respirator operated in a continuous-flow mode.

Particulate concentrations of 250 mg/m^3 or less: Any air-purifying full facepiece respirator with a high-efficiency particulate filter; any SCBA with a full facepiece; any supplied-air respirator with a full facepiece.

Particulate concentrations of 9300 mg/m^3 or less: Any supplied-air respirator with a full facepiece and operated in a pressure-demand or other positive mode.

Emergency or planned entry in unknown concentration or IDLH:** Any SCBA with full facepiece and operated in a pressure-demand or other positive-pressure mode; any supplied-air respirator with a full facepiece and operated in pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in pressure-demand or other positive-pressure mode.

Escape: Any air-purifying full facepiece respirator with a high-efficiency particulate filter and acid-gas cartridge; any appropriate escape-type SCBA.

* Substance causes eye irritation or damage; eye protection needed.

** For purpose of respirator selection, the Immediately Dangerous to Life or Health (IDLH) levels represent the maximum concentration from which one could escape within 30 minutes without any escape-impairing symptoms or any irreversible health effects.

VIII. STORAGE AND HANDLING

Store in a cool, dry, well-ventilated area. Keep away from incompatible materials, heat, and ignition sources.

Store in suitable labelled containers. Keep tightly closed when not in use and when empty.

Use phthalates in minimum quantities, in designated areas with adequate ventilation and away from sources of heat and sparks.

IX. FIRST AID

The following general procedures are suggested for first aid involving poisoning by phthalates:

Inhalation

Remove the source of contamination, if it can be done safely, or move the victim to fresh air. Restore or support breathing if required. Obtain medical advice immediately.

Skin

Wash skin gently and thoroughly with water and a non-abrasive soap. Completely decontaminate clothing, shoes and leather goods before reuse, or discard.

Eyes

Immediately flush the contaminated eye(s) with lukewarm, gently flowing water for 20 minutes, by the clock, holding the eyelid(s) open. If irritation persists, obtain medical attention immediately.

Ingestion

Never give anything by mouth if the victim is rapidly losing consciousness, or is unconscious or convulsing.

DO NOT INDUCE VOMITING. Have the victim drink 240 to 300 mL (8 to 10 oz.) of water. If vomiting occurs naturally, have the victim lean forward to reduce the risk of aspiration. Repeat administration of water. Obtain medical attention immediately.

General

Consult a physician and/or the nearest Poison Control Centre for all cases of ingestion and all but trivial cases of inhalation and eye contact.

X. FIRE FIGHTING

For fires involving phthalates, recommended types of extinguishers are carbon dioxide, dry chemical or foam. Water or foam may cause frothing. Fire fighters must use a self-contained breathing apparatus and full protective clothing.

XI. CLEAN-UP AND DISPOSAL

Provide trained clean-up personnel with adequate ventilation, protective clothing and appropriate respirators. Remove all sources of heat, sparks or flame before attempting to clean a spill. Stop the flow of the material if it can be

done safely. Soak up small spills with an absorbent material (sand, earth) which does not react with the spilled chemical. Put the material in suitable, covered, labelled containers. For large spills, contact fire and emergency services and the supplier for advice.

Consult federal, provincial and local governments for advice on disposal. Large quantities of waste phthalates can be disposed of at designated landfill sites or incinerated at approved sites.

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Note: Additional references on this subject are available from CCOHS upon request.

PLEASE NOTE

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This summary was prepared at the Canadian Centre for Occupational Health and Safety (CCOHS) and is intended primarily as a source of information for persons who work with or may be occupationally exposed to this material. The information selected for inclusion is believed to be reliable and generally relevant to occupational health. Other information which bears on particular work situations may be available. The scientific data in many areas are limited and may allow a variety of interpretations. Additional information, corrections, comments and questions are welcome, and should be addressed to the Inquiries Service, CCOHS, 250 Main Street East, Hamilton, Ontario, L8N 1H6, (416) 572-2981; toll free 1-800-263-8276.

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